

CLAIMS

Having thus described the aforementioned invention, we claim:

1. A medical apparatus for safely navigating a lumen using a catheter, which can also differentiate between various objects found within the lumen, and for treating various conditions existing within the lumen, said medical apparatus comprising:

a catheter;

a plurality of diagnostic optical fibers carried by said catheter;

a plurality of optical source inputs;

a plurality of optical detector outputs;

an optical junction;

a first optical switch in optical communication between said plurality of optical source inputs and said optical junction, said first switch selectively optically connecting one of said plurality of optical source inputs to said optical junction;

a second optical switch in optical communication between said plurality of optical detector outputs and said optical junction, said second switch optically connecting one of said plurality of optical detector outputs to said optical junction so as to receive a reflectance introduced in said plurality of diagnostic optical fibers subsequent to activation of one of said plurality of optical source inputs; and

a third optical switch in optical communication between said optical junction and said plurality of diagnostic optical fibers, said third switch selectively optically connecting said optical junction to one of said plurality of diagnostic optical fibers.

2. The medical apparatus of Claim 1 further comprising a controller providing position awareness of and switching control over said first optical switch, said second optical switch, and said third optical switch.

3. The medical apparatus of Claim 1 further comprising a controller in communication with said first optical switch and said second optical switch, wherein said first optical switch has a plurality of inputs and an output and wherein said second optical switch has an input and a plurality of outputs, said controller performing a method for sequencing the operation of said medical apparatus, said

method comprising the steps of:

operating said first optical switch to connect a selected one of said first optical switch plurality of inputs to said first optical switch output;

cycling said third optical switch such that said third optical switch input is sequentially connected to each of a selected group of said third optical switch plurality of outputs.

4. The medical apparatus of Claim 1 further comprising a controller in communication with said first optical switch and said second optical switch, wherein said first optical switch has a plurality of inputs and an output and wherein said second optical switch has an input and a plurality of outputs, said controller performing a method for sequencing the operation of said medical apparatus, said method comprising the steps of:

operating said third optical switch to connect said third optical switch input to a selected one of said third optical switch plurality of outputs;

cycling said first optical switch such that each of a selected group of said first optical switch plurality of inputs are sequentially connected to said first optical switch output.

5. The medical apparatus of Claim 1 further comprising a controller in communication with said first optical switch and said second optical switch, wherein said first optical switch has a plurality of inputs and an output and wherein said second optical switch has an input and a plurality of outputs, said controller performing a method for sequencing the operation of said medical apparatus, said method comprising the steps of:

operating said second optical switch such that said second optical switch input is connected to a selected one of said second optical switch plurality of outputs;

cycling said third optical switch such that said third optical switch input is sequentially connected to each of a selected group of said third optical switch plurality of outputs.

6. The medical apparatus of Claim 1 further comprising a controller in communication with said first optical switch and said second optical switch, wherein

said first optical switch has a plurality of inputs and an output and wherein said second optical switch has an input and a plurality of outputs, said controller performing a method for sequencing the operation of said medical apparatus, said method comprising the steps of:

operating said third optical switch to connect said third optical switch input to a selected one of said third optical switch plurality of outputs;

cycling said second optical switch such that said second optical switch input is sequentially connected to each of a selected group of said second optical switch plurality of outputs.

7. The medical apparatus of Claim 1 wherein said optical junction optically isolates said plurality of optical source inputs from said reflections.

8. The medical apparatus of Claim 1 wherein said optical junction is an optical circulator configured to optically connect said plurality of optical source inputs with said plurality of diagnostic optical fibers in a first direction and optically isolate said plurality of optical source inputs from said plurality of diagnostic optical fibers in an opposite direction, to optically connect said plurality of optical detector outputs with said plurality of diagnostic fibers, and to optically isolate said plurality of optical detector outputs from said plurality of optical source inputs.

9. The medical apparatus of Claim 1 further comprising:
a treatment optical fiber carried by said catheter; and
a treatment laser optically connected to said treatment optical fiber.

10. The medical apparatus of Claim 1 further comprising:
a treatment optical fiber carried by said catheter; and
a treatment laser optically connected to said treatment optical fiber, wherein said first optical switch optically isolates said plurality of optical source inputs from said plurality of diagnostic optical fibers during operation of said treatment laser.

11. The medical apparatus of Claim 1 further comprising:
a treatment optical fiber carried by said catheter; and

a treatment laser optically connected to said treatment optical fiber, wherein said second optical switch optically isolates said plurality of optical detector outputs from said plurality of diagnostic optical fibers during operation of said treatment laser.

12. The medical apparatus of Claim 1 further comprising a conduit defined by said catheter, said at conduit adapted for a procedure selected from the group consisting of fluid removal, angioplasty balloon insertion, angioplasty balloon inflation, and stent insertion.

13. The medical apparatus of Claim 1 further comprising a plurality of sources each producing light of a selected wavelength, each of said plurality of sources connected to one of said plurality of optical source inputs.

14. The medical apparatus of Claim 1 further comprising a plurality of detectors each responsive to light of a selected wavelength, each of said plurality of detectors connected to one of said plurality of optical detector outputs.

15. A medical apparatus for safely navigating a lumen using a catheter, which can also differentiate between various objects found within the lumen, and for treating various conditions existing within the lumen, said medical apparatus comprising:

- a catheter;
- a diagnostic optical fiber carried by said catheter;
- a plurality of optical source inputs;
- an optical junction in optical communication with said diagnostic optical fiber;
- an optical switch in optical communication between said plurality of optical source inputs and said optical junction, said optical switch optically connecting a selected one of said plurality of optical source inputs to said optical junction; and
- an optical detector output responsive to light of a selected wavelength, said optical detector output in optical communication with said optical junction so as to receive a reflectance introduced in said diagnostic optical fiber subsequent to activation of one of said plurality of optical source inputs.

16. The medical apparatus of Claim 15 further comprising a controller

providing position awareness of and switching control over said optical switch.

17. The medical apparatus of Claim 15 wherein said plurality of optical source inputs is optically isolated from said reflections.

18. The medical apparatus of Claim 15 wherein said optical junction is an optical circulator configured to optically connect said plurality of optical source inputs with said diagnostic optical fiber in a first direction and optically isolate said plurality of optical source inputs from said diagnostic optical fiber in an opposite direction, to optically connect said optical detector output with said diagnostic optical fiber, and to optically isolate said optical detector output from said plurality of optical source inputs.

19. The medical apparatus of Claim 15 further comprising:

a treatment optical fiber carried by said catheter; and

a treatment laser optically connected to said treatment optical fiber

20. The medical apparatus of Claim 15 further comprising:

a treatment optical fiber carried by said catheter; and

a treatment laser optically connected to said treatment optical fiber, wherein said first optical switch optically isolates said plurality of optical source inputs from said diagnostic optical fiber during operation of said treatment laser.

21. The medical apparatus of Claim 15 further comprising a conduit defined by said catheter, said conduit adapted for a procedure selected from the group consisting of fluid removal, angioplasty balloon insertion, angioplasty balloon inflation, and stent insertion.

22. The medical apparatus of Claim 15 further comprising a plurality of sources each producing light of a selected wavelength, each of said plurality of sources connected to one of said plurality of optical source inputs.

23. The medical apparatus of Claim 15 wherein said diagnostic optical fiber ends in a mirror disposed at a substantially 45 degree angle.

24. A medical apparatus for safely navigating a lumen using a catheter, which can also differentiate between various objects found within the lumen, and for treating various conditions existing within the lumen, said medical apparatus comprising:

- a catheter;
- a diagnostic optical fiber carried by said catheter;
- an optical source input producing light having a selected wavelength;
- a plurality of optical detector outputs;
- an optical junction optically connecting said optical source input and said diagnostic optical fiber; and
- an optical switch in optical communication between said plurality of optical detector outputs and said optical junction, said optical switch optically connecting one of said plurality of optical detector outputs to said optical junction so as to receive reflectances introduced in said diagnostic optical fiber subsequent to activation of said optical source input.

25. The medical apparatus of Claim 24 further comprising a controller providing position awareness of and switching control over said optical switch.

26. The medical apparatus of Claim 24 wherein said optical source input is optically isolated from said reflectances.

27. The medical apparatus of Claim 24 wherein said optical junction is an optical circulator configured to optically connect said optical source input with said diagnostic optical fiber in a first direction and optically isolate said optical source input from said diagnostic optical fiber in an opposite direction, to optically connect said plurality of optical detector outputs with said diagnostic optical fiber, and to optically isolate said plurality of optical detector outputs from said optical source input.

28. The medical apparatus of Claim 24 further comprising:

- a treatment optical fiber carried by said catheter; and
- a treatment laser optically connected to said treatment optical fiber.

29. The medical apparatus of Claim 24 further comprising:
a treatment optical fiber carried by said catheter; and
a treatment laser optically connected to said treatment optical fiber, wherein
said optical switch optically isolates said plurality of optical detector outputs from said
diagnostic optical fiber during operation of said treatment laser.

30. The medical apparatus of Claim 24 further comprising:
a treatment optical fiber carried by said catheter;
a treatment laser optically connected to said treatment optical fiber; and
an optical dead-end in communication with said optical switch, said optical
switch optically connecting said optical dead-end and said optical junction during
operation of said treatment laser.

31. The medical apparatus of Claim 24 further comprising a conduit defined by
said catheter, said at conduit adapted for a procedure selected from the group
consisting of fluid removal, angioplasty balloon insertion, angioplasty balloon inflation,
and stent insertion.

32. The medical apparatus of Claim 24 further comprising a plurality of
detectors each responsive to light of a selected wavelength, each of said plurality of
detectors connected to one of said plurality of optical detector outputs.

33. The medical apparatus of Claim 24 wherein said diagnostic optical fiber
ends in a mirror disposed at a substantially 45 degree angle.

34. A medical apparatus for safely navigating a lumen using a catheter, which
can also differentiate between various objects found within the lumen, and for treating
various conditions existing within the lumen, said medical apparatus comprising:
a catheter;
a diagnostic optical fiber carried by said catheter;
a plurality of optical source inputs;
a plurality of optical detector outputs;
an optical junction in optical communication with said diagnostic optical fiber;

a first optical switch in optical communication between said plurality of optical source inputs and said optical junction, said first optical switch optically connecting a selected one of said plurality of optical source inputs to said optical junction; and

a second optical switch in optical communication between said plurality of optical detector outputs and said optical junction, said second optical switch optically connecting one of said plurality of optical detector outputs to said optical junction so as to receive reflectances introduced in said diagnostic optical fiber subsequent to activation of one of said plurality of optical source inputs.

35. The medical apparatus of Claim 34 further comprising a controller providing position awareness of and switching control over said first optical switch and said second optical switch.

36. The medical apparatus of Claim 34 wherein said plurality of optical source inputs is optically isolated from said reflections.

37. The medical apparatus of Claim 34 wherein said optical junction is an optical circulator configured to optically connect said plurality of optical source inputs with said diagnostic optical fiber in a first direction and optically isolate said plurality of optical source inputs from said diagnostic optical fiber in an opposite direction, to optically connect said plurality of optical detector outputs with said diagnostic optical fiber, and to optically isolate said plurality of optical detector outputs from said plurality of optical source inputs.

38. The medical apparatus of Claim 34 further comprising:
a treatment optical fiber carried by said catheter; and
a treatment laser optically connected to said treatment optical fiber.

39. The medical apparatus of Claim 34 further comprising:
a treatment optical fiber carried by said catheter; and
a treatment laser optically connected to said treatment optical fiber, wherein said first optical switch optically isolates said plurality of optical source inputs from said diagnostic optical fiber during operation of said treatment laser.

40. The medical apparatus of Claim 34 further comprising:
a treatment optical fiber carried by said catheter; and
a treatment laser optically connected to said treatment optical fiber, wherein
said second optical switch optically isolates said plurality of optical detector outputs
from said diagnostic optical fiber during operation of said treatment laser.

41. The medical apparatus of Claim 34 further comprising:
a treatment optical fiber carried by said catheter; and
a treatment laser optically connected to said treatment optical fiber; and
an optical dead-end in communication with said second optical switch, said
second optical switch optically connecting said optical dead-end and said optical
junction during operation of said treatment laser.

42. The medical apparatus of Claim 34 further comprising a conduit defined by
said catheter, said at conduit adapted for a procedure selected from the group
consisting of fluid removal, angioplasty balloon insertion, angioplasty balloon inflation,
and stent insertion.

43. The medical apparatus of Claim 34 further comprising a plurality of
sources each producing light of a selected wavelength, each of said plurality of sources
connected to one of said plurality of optical source inputs.

44. The medical apparatus of Claim 34 further comprising a plurality of
detectors each responsive to light of a selected wavelength, each of said plurality of
detectors connected to one of said plurality of optical detector outputs.

45. The medical apparatus of Claim 34 wherein said diagnostic optical fiber
ends in a mirror disposed at a substantially 45 degree angle.

46. A medical apparatus for safely navigating a lumen using a catheter, which
can also differentiate between various objects found within the lumen, and for treating
various conditions existing within the lumen, said medical apparatus comprising:

a catheter;

a plurality of diagnostic optical fibers carried by said catheter;

a plurality of optical source inputs;

an optical junction;

a first optical switch in optical communication between said plurality of optical source inputs and said optical junction, said first optical switch optically connecting a selected one of said plurality of optical source inputs to said optical junction;

a second optical switch in optical communication between said optical junction and said plurality of diagnostic optical fibers, said second optical switch optically connecting a selected one of said plurality of diagnostic optical fibers to said optical junction; and

an optical detector output responsive to light of a selected wavelength, said optical detector output in optical communication with said optical junction so as to receive a reflectance introduced in said plurality of diagnostic optical fibers subsequent to activation of one of said plurality of optical source inputs.

47. The medical apparatus of Claim 46 further comprising a controller providing position awareness of and switching control over said first optical switch and said second optical switch.

48. The medical apparatus of Claim 46 further comprising a controller in communication with said first optical switch and said second optical switch, wherein said first optical switch has a plurality of inputs and an output and wherein said second optical switch has an input and a plurality of outputs, said controller performing a method for sequencing the operation of said medical apparatus, said method comprising the steps of:

operating said first optical switch to connect a selected one of said first optical switch plurality of inputs to said first optical switch output;

cycling said third optical switch such that said third optical switch input is sequentially connected to each of a selected group of said third optical switch plurality of outputs.

49. The medical apparatus of Claim 46 further comprising a controller in communication with said first optical switch and said second optical switch, wherein said first optical switch has a plurality of inputs and an output and wherein said

second optical switch has an input and a plurality of outputs, said controller performing a method for sequencing the operation of said medical apparatus, said method comprising the steps of:

operating said third optical switch to connect said third optical switch input to a selected one of said third optical switch plurality of outputs;

cycling said first optical switch such that each of a selected group of said first optical switch plurality of inputs are sequentially connected to said first optical switch output.

50. The medical apparatus of Claim 46 wherein said plurality of optical source inputs is optically isolated from said reflections.

51. The medical apparatus of Claim 46 wherein said optical junction is an optical circulator configured to optically connect said plurality of optical source inputs with said plurality of diagnostic optical fibers in a first direction and optically isolate said plurality of optical source inputs from said plurality of diagnostic optical fibers in an opposite direction, to optically connect said optical detector output with said plurality of diagnostic optical fibers, and to optically isolate said optical detector output from said plurality of optical source inputs.

52. The medical apparatus of Claim 46 further comprising:
a treatment optical fiber carried by said catheter; and
a treatment laser optically connected to said treatment optical fiber, wherein said first optical switch optically isolates said plurality of optical source inputs from said plurality of diagnostic optical fibers during operation of said treatment laser.

53. The medical apparatus of Claim 46 further comprising a conduit defined by said catheter, said conduit adapted for a procedure selected from the group consisting of fluid removal, angioplasty balloon insertion, angioplasty balloon inflation, and stent insertion.

54. The medical apparatus of Claim 46 further comprising a plurality of sources each producing light of a selected wavelength, each of said plurality of sources

connected to one of said plurality of optical source inputs.

55. A medical apparatus for safely navigating a lumen using a catheter, which can also differentiate between various objects found within the lumen, and for treating various conditions existing within the lumen, said medical apparatus comprising:

- a catheter;
- a plurality of diagnostic optical fibers carried by said catheter;
- an optical source input producing light having a selected wavelength;
- a plurality of optical detector outputs;
- an optical junction in optical communication with said optical source input;

and

- a first optical switch in optical communication between said plurality of optical detector outputs and said optical junction, said first optical switch optically connecting one of said plurality of optical detector outputs to said optical junction so as to receive reflectances introduced in said diagnostic optical fiber subsequent to activation of said optical source input; and

- a second optical switch in optical communication between said optical junction and said plurality of diagnostic optical fibers, said second optical switch optically connecting a selected one of said plurality of diagnostic optical fibers to said optical junction.

56. The medical apparatus of Claim 55 further comprising a controller providing position awareness of and switching control over said first optical switch and said second optical switch.

57. The medical apparatus of Claim 55 further comprising a controller in communication with said first optical switch and said second optical switch, wherein said first optical switch has a plurality of inputs and an output and wherein said second optical switch has an input and a plurality of outputs, said controller performing a method for sequencing the operation of said medical apparatus, said method comprising the steps of:

- operating said second optical switch such that said second optical switch input is connected to a selected one of said second optical switch plurality of outputs;

cycling said third optical switch such that said third optical switch input is sequentially connected to each of a selected group of said third optical switch plurality of outputs.

58. The medical apparatus of Claim 55 further comprising a controller in communication with said first optical switch and said second optical switch, wherein said first optical switch has a plurality of inputs and an output and wherein said second optical switch has an input and a plurality of outputs, said controller performing a method for sequencing the operation of said medical apparatus, said method comprising the steps of:

operating said third optical switch to connect said third optical switch input to a selected one of said third optical switch plurality of outputs;

cycling said second optical switch such that said second optical switch input is sequentially connected to each of a selected group of said second optical switch plurality of outputs.

59. The medical apparatus of Claim 55 wherein said optical source input is optically isolated from said reflectances.

60. The medical apparatus of Claim 55 wherein said optical junction is an optical circulator configured to optically connect said optical source input with said plurality of diagnostic optical fibers in a first direction and optically isolate said optical source input from said plurality of diagnostic optical fibers in an opposite direction, to optically connect said plurality of optical detector outputs with said plurality of diagnostic optical fibers, and to optically isolate said plurality of optical detector outputs from said optical source input.

61. The medical apparatus of Claim 55 further comprising:
a treatment optical fiber carried by said catheter; and
a treatment laser optically connected to said treatment optical fiber, wherein said first optical switch optically isolates said plurality of optical detector outputs from said plurality of diagnostic optical fibers during operation of said treatment laser.

62. The medical apparatus of Claim 55 further comprising:
a treatment optical fiber carried by said catheter;
a treatment laser optically connected to said treatment optical fiber; and
an optical dead-end in communication with said first optical switch, said first optical switch optically connecting said optical dead-end and said optical junction during operation of said treatment laser.

63. The medical apparatus of Claim 55 further comprising a conduit defined by said catheter, said at conduit adapted for a procedure selected from the group consisting of fluid removal, angioplasty balloon insertion, angioplasty balloon inflation, and stent insertion.

64. The medical apparatus of Claim 55 further comprising a plurality of detectors each responsive to light of a selected wavelength, each of said plurality of detectors connected to one of said plurality of optical detector outputs.

65. A method for combining multiple techniques in a single catheter experience using a medical device having a plurality of optical inputs, a plurality of optical outputs, an optical junction, a plurality of optical fibers carried by a catheter, and a controller, said method comprising the steps of:

- (a) connecting one of a plurality of optical inputs to an optical junction;
- (b) connecting said optical junction to one of a plurality of optical outputs; and
- (c) sequentially connecting said optical junction to a each of a selected group of a plurality of optical fibers.

66. A medical apparatus for safely navigating a lumen using a catheter, which can also differentiate between various objects found within the lumen, and for treating various conditions existing within the lumen, said medical apparatus comprising:

- means for receiving diagnostic illumination from a plurality of optical sources;
- means for providing passage through a lumen;
- plurality of means for carrying said diagnostic illumination and corresponding reflectances through said means for providing passage though a lumen;
- means for distributing said reflectances from said means for carrying said

diagnostic illumination and corresponding reflectances to a plurality of optical detectors;

means for injecting the diagnostic illumination from a selected one of the plurality of optical sources into said means for carrying said diagnostic illumination and corresponding reflectances;

means for injecting the reflectances from said means for carrying said diagnostic illumination and corresponding reflectances into a selected one of the plurality of detectors; and

means for routing the diagnostic illumination through and the reflectances from said means for carrying the diagnostic illumination and corresponding reflectances.

67. The medical apparatus of Claim 66 further comprising means for controlling said means for injecting the diagnostic illumination, means for injecting the reflectances, and said means for routing.